The Effects of Auditory Distractors in a Word Learning Task

Research Thesis

Presented in partial fulfillment of the requirements for graduation *with research distinction* in Psychology in the undergraduate colleges of The Ohio State University

By

Lauren Evano

The Ohio State University

April 2014

Project Advisor: Julie Hupp Ph.D., Department of Psychology

Abstract

The topic of learning with background sound has been a widely researched field of study. This research examined whether word learning performance is affected by the presence of background noise, such as music or television in an Easy (Study 1) and Difficult (Study 2) word learning task. In Study 1, college undergraduate students (*n*=98) were presented novel objects (modern art sculptures) with an auditory nonsense label for each object. Four background sound conditions were used: calm music, pop music, silence and television weather excerpts. The results indicated there was a main effect of the participants' perceived distraction on the accuracy of the participants' scores; the more distracting the participants perceived the background sound to be, the lower their word learning. A second study of college undergraduate students (*n*=100) was conducted to test task reliability and to determine if background noise had the same effect on a more difficult word learning task. For Study 2, the number of word presentations during training was reduced to make the task more difficult. The sound conditions remained the same. The results from Study 2 indicated there was a main effect of background sound on word learning performance during a difficult task. Participants in sound conditions with vocals had lower accuracy scores than those in the non-vocal sound condition. The more difficult a task, the more detrimental sound with vocals is on performance in contrast to an easier task where background noise was only detrimental if the participants perceived it to be distracting. This may have implications for how classroom environments are structured.

The Effects of Auditory Distractors in a Word Learning Task

Background distractions may be detrimental when attempting to learn new material. Studying the effects of background sound on learning has been a subject of interest in the past; however, there has not been a clear answer to the question of how or why background sound affects learning (Jancke & Sandmann, 2010). In some studies, college students showed improved memory recall during a reading task with the presence of background music in comparison to silence (Kiger, 1989), whereas in other studies, background music hinders learning (Furnham & Strbac, 2002; Perham & Sykora, 2012). It is common that college students listen to MP3 players or other portable music devices while they are studying. In a study investigating the usage and habits of college students, researchers found that 76.5% of participants used their MP3 player two hours or less for three or more days a week (Hoover & Krishnamurti, 2010). Additionally, 85% of the participants admitted to using only one earphone in order to multi-task such as holding a conversation, exercising or during a reading activity (Hoover & Krishnamurti, 2010). Students regularly study with background sound, but it is not clear how this is affecting their learning. Additional studies of adolescents have discovered that when students are completing a reading comprehension task, performance is worse while listening to music (Anderson & Fuller, 2010). Although research does not provide a clear picture of how background noise affects learning, studies tend to find that background noise usually hinders performance across a variety of cognitive tasks.

Overview

Throughout the course of this paper, there will be many topics investigated in order to determine if background noise is detrimental to word learning. These research ideas will include background noise as a distraction, working memory, study habits and individual distraction, task complexity and finally, the current study. The previous literature will be analyzed and applied to investigate the specific factors of background noise that may affect learning during a word learning task. The research presented about background noise being detrimental in certain tasks leads to the hypothesis that background noise is only detrimental in some scenarios, and identifying the factors underlying this effect will help clarify these mixed results.

Background Noise as a Distraction

Previous studies have investigated different domains of learning with background noise. For example, Furnham and Strbac (2002) investigated the effects of background noise on a variety of cognitive tasks. In this study, participants were assigned to one out of the three possible sounds conditions: typical office noises (phones ringing or typewriters), garage music (music with high tempos and varying melodies), and silence. During the study, participants completed a reading comprehension task, a memory recall from prose writing task, and a simple mental arithmetic task. The results of the study indicated that performance was hindered with the presence of the background noise, especially garage music, in comparison to the silent condition across all cognitive tasks. These findings support the idea that background noise hinders performance on cognitive tasks.

Even though the overwhelming conclusion of previous research is that background music hinders learning performance, background noise is not always detrimental to learning as seen in previous studies where the effects of background music were investigated in regards to learning verbal stimuli (Jancke & Sandmann, 2010) where researchers discovered that background noise was not detrimental to verbal learning in regards to memory recall. Previous research by Jancke and Sandmann (2010), investigated if music tempo (fast vs. slow) or consonance (in-tune vs. out-of-tune) had an effect on verbal learning in comparison to silence. Verbal learning was measured by a memory recall task of lists of words. Results of this study indicated that there was no significant findings regarding the effects of music tempo or consonance in verbal learning; participants' learning was comparable across all conditions.

When learning information with music in the background, a person has the option of purely instrumental music or music with lyrics. So, a person's individual distraction level can also be affected by the presence of vocals in their background music. In a study by Crawford and Strapp (1994), participants were required to complete three cognitive tasks: a maze tracing speed test, deciphering of languages test (logical reasoning), and an object or number recall test. There were three different conditions: silence, vocal music, and non-vocal music. The participants completed the three cognitive tasks either with the presence of background music or in silence. After the cognitive test, participants answered various questionnaires to assess their learning performance. Those in the silence condition performed better than those in the music conditions. Individuals in the vocal music condition performed worse on all three cognitive tasks in contrast to participants in the non-vocal music condition. This could be due to vocal music being more distracting than non-vocal music because vocal music contains lyrics and music (Crawford & Strapp, 1994). This might make the task more difficult for the participant because they have to screen out not only music but also vocals and then attend to the task at hand which might be exhaustive of cognitive resources and could result in decreased performance. A source of exhaustive cognitive resources might be due to the task at hand requiring processing across multiple domains (such as in a word learning task). This processing across multiple domains requires more resources and may require more concentration. The presence of background noise competes with the verbal stimuli for resources and may result in lowered performance.

Working Memory

Additional research has been conducted on the effects of different background noise selections on working memory in regards to speech reading displaying that there were no effects of background noise. Working memory, by definition, refers to the temporary storage of information that is being processed in any of a range of cognitive tasks (Baddeley, 1993). This could also be related to the part of short-term memory that is associated with conscious perception and linguistic processing (Lyxell &Ronnber, 1993). In other words, working memory is associated with perceiving stimuli and then processing them into meaningfulness in regards to specific words. In a study by Lyxell and Ronnberg (1993), Swedish- speaking participants were directed to complete one of two tasks. The first task was to read a series of Swedish words and then they were tested to see if they could recall the words presented to them. The second task was similar to the first task; however, Swedish-speaking participants had to read a series of sentences containing 3-4 Swedish words. They were tested similarly by measuring if they could recall any of the words that they had previously read. There were three background noise conditions that occurred during the tasks. There was either the presence of white noise or a background noise that consisted of a female reading a passage of Swedish history. Silence was used as a control condition. The results of this study revealed that there were no main effects of background noise on either of the two reading tasks. This poses the idea that background noise does not impair working memory in regards to reading words aloud.

Additional studies on working memory are currently investigating this disruption of verbal material and the effects of serial recall. In a previous study, researchers discovered that those participants in a vocal music background noise condition were more disrupted and distracted than in an instrumental or silent background noise condition (Salame & Baddeley, 1989). Researchers also credit these findings to working memory issues when background noise containing vocals is present during a working memory task. Participants were required to complete a study in which they had to complete a serial recall task of nine digits. Throughout the course of the experiment, the participants were interrupted by either vocal music, non-vocal music or silence. The results of the study indicated that those in the vocal music condition performed significantly worse than those in the non-vocal music or silence conditions. These results indicate that working memory is negatively affected by the presence of vocal background music. Although previous literature has proposed the idea that background noise containing vocals is detrimental to working memory performance, it is not necessarily clear that this information would extend beyond musical selections to non- musical selections such as TV background noise.

Working memory and the Phonological Loop may be related with one another in their relationship with word learning. In previous research, the phonological loop has been described as being specialized for the retention of verbal information over short periods of time which is composed of two parts: the phonological store and a rehearsal process (Baddeley, Gathercole & Papagno, 1998). This phonological loop could be potentially related to how individuals learn new words. Additionally, background noise may negatively affect this loop by posing as a distraction and thus individuals may not be able to store or rehearse these novel words due to the background noise interfering with the phonological loop.

In a previous study, researchers investigated if multitasking impaired studying and the comprehension of novel material (Pashler, Kang, & Ip, 2013) which can also be connected to working memory. This connection is due to the notion that multi-tasking uses up cognitive resources in regards to working memory. The more multi-tasking that is occurring, the more cognitive resources that are being taken away from the working memory capacity. This study consisted of three experiments regarding multitasking and studying. In each of the studies, participants read nine to ten paragraphs and then were quizzed to see how much of the material they knew. In the first experiment, the participants read the paragraphs. The conditions were if the participants were interrupted or not while reading the paragraphs. They were either interrupted at the end of each paragraph, interrupted randomly or not interrupted. In the second experiment, participants had the paragraphs read to them and were interrupted in the same way as experiment one. The first two experiments found that interruptions did not affect learning. However, in the third experiment, researchers placed a second narrator during these tasks, and participants were either given the option to pause or not pause their task while the narrator was speaking. The results were that multi-tasking does result in a misunderstanding of the information; especially when the information is played not waiting for the participants (Pashler, et al., 2013). Those that were allowed to pause the paragraphs on their own had higher reading comprehension scores. This previous research is related to working memory due to the fact that participants' working memory was interrupted while they were learning. This interruption impaired their ability to store the incoming information into their long-term memory.

Study Habits and Individual Distraction

The potential negative effect of distractors in a learning situation may be attributed to the various study habits students have. Examining these study habits may help to determine what is distracting to a certain individual and may account for why some students are affected by background noise and others are not. For example, Elliot and Godshall (1990) investigated the effects of study habits on academic performance and problem-solving abilities of college students. Participants were required to self-report on a 6-point Likert scale on Problem-Solving Confidence, Approach-Avoidance (i.e., how comfortable they are beginning new challenges), and Personal Control. Additionally, participants completed a survey listing 100 items that describe various study habits. These items included if participants studied with music or if the participants would daydream while studying. Participants then participated in a mock course aimed at enhancing academic skills of unprepared college students. Students with better study habits (e.g., did not listen to music while studying) received better scores in the mock course. These students also had higher problem-solving confidence than those students whose study habits were less effective. The results indicate that poor study habits including listening to background music while studying was related to worse performance and reduced confidence in their academics.

In addition, researchers have investigated whether background music differentially affected reading comprehension in individuals who normally study with music and individuals who do not (Etaugh & Ptasnik, 1982). The participants were asked to read excerpts from law school preparatory material while music played in the background; there was a silent condition in order to serve as a control. After reading for ten minutes, there was a comprehension quiz. Each participant was given a questionnaire and was asked whether they normally listen to music while they study. Performance was ultimately better when reading in silence. Of the individuals who normally listen to music while they study, even though their scores were better in silence, they were not as hindered in the music condition as much as the individuals who normally did not listen to music while studying. This interaction could be connected to how distracting the participants felt the task to be. If these participants were used to studying with music, then maybe they did not find the background sound as distracting, thus their performance was not as hindered. This can also be related to how people learn to habituate to acoustic distractions (Elliot & Godshall, 2001) as seen in earlier experiments. Specifically, individuals develop different study habits in which their use of background noise might vary from other students during their study sessions. In other words, students might learn to habituate to certain distracting stimuli, such as background noise, and eventually may not find them distracting when they are trying to learn. This individual perceived distraction level may account for the inconsistencies in the literature regarding background noise and learning performance.

Similarly, in a previous study by Kiger (1989), the effects of background music on reading comprehension were investigated and resulted in background noise negatively affecting high information-load scenarios. Participants read a passage of Japanese history and then answered a true-false test in order to assess the extent of their reading comprehension. There were three different sound conditions: silence, low information-load background music (music that was repetitive and synthesized), and high information-load background music (music that was rhythmically varied and complex). Participants in the music conditions read the required passage while the background music was played through headphones. The results revealed that participants in the low information-load background music condition performed better than individuals in the high information-load background music or in the high information- load (a difficult reading comprehension task) silence condition. These different information-load levels may contribute to the different distraction levels that participants are experiencing.

A higher information-load task requires more selective attention and fewer distractions, such as background noises or talking, in order to perform better during a cognitive task (Lavie, 2005). In a review of various studies regarding selective attention and distractions during a learning task, Lavie (2005) concluded that a perceptual load that engages the individual's full attention is necessary in order to prevent distractions during a specific learning task, and thus without an engaging perceptual load, individuals will become distracted more easily by the background noise and would have worsened performance. Specifically instructing participants to focus on a word learning task is not enough to sufficiently prevent goal-irrelevant stimuli, such as background noise, from distracting the participants and will hinder their word learning performance (Lavie, 2005). The findings of the meta-analysis by Lavie (2005) propose that distraction levels play a part in determining the level of hindrance background noise plays on certain cognitive tasks, and there are individual differences on how distractible students are. For example, if students listen to non-vocal background music while they study, they might not be as impaired during a learning task (Salame & Baddeley, 1989). The effect of background noise may just depend on whether or not the individual perceives the background noise to be distracting. Additionally, more difficult tasks require greater use of mental resources (Kiger, 1989), so the presence of background noise during a difficult task may be more distracting and detrimental to learning.

Some researchers have also tested to see whether or not liking the background music makes a difference in learning performance. In a study based primarily on the effects of music preference (Perham & Sykora, 2012), participants viewed a list of letters with either liked music (popular music), disliked music (thrash metal), or silence. Then they recalled the letters after twenty seconds of study time. Participants were screened to ensure that they disliked thrash metal and liked the popular music. The liked music had a high level of acoustic variation–the changing of pitches and tempos within a piece of music. In contrast to the liked music, the disliked music contained a low level of acoustic variation. The results indicated that both kinds of music hindered recall performance; however, those in the disliked music category performed better than those in the liked music category. This is in addition to specific musical preferences and proposes that individuals listening to any music with low levels of acoustic variation could potentially be less hindered in a complex cognitive task such as word learning. This can be due to the theory that low acoustic variation is not as distracting in contrast to a song with high acoustic variation due to tempo changes, pitch changes or lyrical complexity is not present in low acoustic variation music (Perham & Sykora, 2012).

Task Complexity

In recent studies, background music has been shown to influence performance based on the complexity of a task (Kiger, 1989); thus, the more complex a task the more background music hinders performance. For example, in a previous study by Furnham and Allas (1999), participants were required to complete three different cognitive tasks. These tasks were a reading comprehension task, a memory recall task, and an Advanced Progressive Matrices (APM) observation task. The APM task is designed to test a participant's cognitive abilities by showing the participant a series of lines and then instructing the participant to select the best option for completing the series of lines. For example, participants may be shown three parallel lines and then asked which would be the best option of three answer choices to complete the series. During these tasks, participants experienced three different types of background music varying in complexity, tempo, and melody. The results of this study indicated during a more complex task, such as the APM observation task, performance is hindered by background noise more than a less complex task.

One way task complexity might be measured is by the number of modalities required. Word learning falls under the category of a complex task due to the fact that word learning requires learning across modalities. Multi-modal learning, such as combining auditory and visual modes of learning, is a relatively novel approach in regards to the effects of background noise on word learning. This type of research on word learning is important because in a classroom setting, students are exposed to multi-modal learning. This is also true in word-learning scenarios for children in the home. For example, an instructor lectures (Auditory Learning) and then writes the terms on the board or in a slideshow (Visual learning). Word learning tasks may be more representative of how children are learning in a classroom setting in comparison to uni-modal tasks like reading comprehension; however, uni-modal tasks are typically investigated in the research regarding background noise. The literature is lacking in the effects of background noise during a multimodal task. By understanding the effects of background noise on multimodal tasks, this will in turn help understand how to make optimal learning environments both in the home and in the classroom.

Current Study

College students may be used to studying with various background distractors and therefore may not be as hindered by the presence of background noise. Additionally, college students may not perceive background noise to be a distraction, and therefore, it may not affect their learning performance. It would be beneficial to investigate college students’ perceived distraction while listening to different types of background noise (e.g., music with or without vocals, speaking without music) in order to determine the effects of background noise on cognitive ability. The current research will investigate these factors in a word learning task to determine the effect of different types of background noise and students' perceived distraction.

The current research investigates the effect of various types of background distractions on a multimodal learning task; the participants were asked to learn a series of novel words presented auditorally in a series of two studies. Each novel word was represented as a noun label either with or without the presence of background noise depending on the pre-assigned condition. There were four background noise conditions: calm music, pop music, TV excerpts, and a silent control. Of the three sound conditions, some contain music and some contain vocals to investigate the impact on word learning as a function of the type of background noise. The words were shown in either a high frequency or a low frequency to examine if the amount of presentation (i.e., difficulty of the task) influences the participant's learning of the novel words.

Previous studies have indicated that participants perform better in learning tasks with silence or with non-vocal noise selections than with background noise or vocal noise selections. The hypothesis of this research is that background sound conditions will result in lower word learning in comparison to silence, especially with the addition of vocals. Background noise, as mentioned previously, is detrimental in complex or difficult tasks, and therefore, it would be expected to be detrimental in this word learning task as well because individuals have to exert more purposeful cognitive effort to learn the material. It is expected that the background sound conditions, especially background noise with vocals, will lead to higher individual reported distraction levels, which would result in lower accuracy scores. Individual perceived distraction is a person's self-report of how distracting they believe the background sound to be. This plays a part in how successful a person is at completing a certain task (Etaugh & Ptasnik, 1982; Lavie, 2005). This perceived distraction may differ from person to person. This perceived distraction may also be influenced by the type of background sound (e.g., with vocals or non-vocal). When the learning environment makes concentration difficult due to distracting stimuli, word learning accuracy could be significantly lower. Study 1 will investigate the effects of background noise on an easy word learning task (with many training trials), whereas Study 2 will investigate this effect on a more difficult word learning task (with fewer training trials).

Study 1: Easy Word-Learning Task

Method

Participants

There were 98 native-English speaking participants (58 Females, 40 Males) in this study who were all undergraduate students taking an introductory Psychology course at a regional campus of a large Midwestern university. There were 9 additional participants excluded from the data analyses due to incompletion of the study. The age of the participants ranged from 18-26 (*M*=18.97 years, *SD*=2.05). In return for participating in the study, students received credit for their research requirements in their Introduction to Psychology class.

Materials

The words selected for this experiment were all nonsense words (e.g., *floogle*). All of the nonsense words were selected from search engine results for nonsense words; there were 24 words in total. Twenty words were used in the training phase, as seen in Appendix A, and four words were added for the Yes/No test. The frequency of presentation of these words varied. Approximately half of the words were low frequency, which consisted of being presented two times, and the remaining words were high frequency, which consisted of being presented four times. This led to 60 trials in total. The selection of which words were to be high frequency was randomly determined. All of these nonsense words were presented as nouns labeling an object. For example, “This is a *floogle*” would be heard by the participant. The nonsense words were recorded on a digital voice recorder by a female speaker and then accompanied a PowerPoint slide as an auditory label for each of the objects. The PowerPoint presentation of the words and objects consisted of 60 slides during the training phase of the experiment. The 24 objects in this study (20 objects in the main presentation and 4 additional objects in the Yes/No test) were selected to be unknown objects to the participants. The majority of the objects were sculptures of modern art, as seen in Appendix A.

The background auditory stimuli were played through headphones. The background sound consisted of four between-subjects conditions: silence, calm music, pop music and TV selections. There were three different selections for each background noise condition lasting for an approximate total time of 7.5 minutes. Each background selection lasted approximately 2.5 minutes. Upon completion, each background noise selection faded into the new following background noise selection. The music selections for the calm condition were all non-vocal songs. For example, the calm music selections consisted of piano or jazz music. These music selections were slow in tempo. The pop music were all song selections from the top 10 chart of popular music which can be found on i-Tunes, a music website for downloading music. The pop music consisted of two male and two female voices in the lyrics. The pop music consisted of selections from “Back in Time’ by Pitbull, “Want U Back” by Cher Lloyd, and “Good Times” by Owl City and Carly Rae Jepson. The TV selections were downloaded from YouTube consisting of three local news channels’ weather broadcasts about small amounts of incoming snow. Each track for the TV selections was of a separate news broadcast. The TV selections had two male and one female voice. The background sound stimuli were each played at the same comfortable volume level, which was at 50% of the speaker volume.

The labeling statements which were played over-top of the background noise were pretested to ensure that participants could understand the auditory labels similarly across all sound conditions. A pilot study of 57 separate participants was used to determine that participants could clearly hear the recorded auditory labels for each object above the background noise. Participants were asked to write down what nonsense word they heard. Judging by the phonetics of the word they indicated, it was determined that the participants were able to hear the recorded auditory labels. The responses to the pilot study were scored on a scale of 0-3 with 0 being phonetically dissimilar, 1 being incorrect, 2 being marginally correct with similar phonetics, and 3 being phonetically the same. For example, if the word was '*floogle'*, the participant would have had to have written '*floogle'* or *'flugle'* to receive a score of 3, but *flample* would have earned a score of 0. A score of 2, the participant would have to have written '*fluggle'*. Similarly, '*fuggle'* would receive a score of 1. Each nonsense word had an average score across all participants in the pilot study. A Univariate Analysis of Variance revealed that participants were hearing the words similarly across all sound conditions where, $F(2,56)=.672$, $p<.05$, partial $\eta^2=.02$. Specifically the participants' means were as follows: Calm ($M=2.70$, $SD=.26$), Pop ($M=2.70$, $SD=.26$) and TV ($M=2.78$, $SD=.25$). If the nonsense word received and overall score of 2 or better, then the word was deemed audible and was acceptable to be used in the main study.

Following the training phase, a Yes/No test was given to calculate how well the participants learned the nonsense words. The Yes/No test consisted of 24 questions with 12 of the questions being "no." Each question in the Yes/No test was auditorally and visually presented in the PowerPoint. For example, an object would be displayed on the screen, and the participant would hear the phrase, "Is this a *floogle?*" Of the questions with a "no" response, there were three different foils: old word with new object, new word with old object, and old word with wrong old object. For the old word with new object foil, a previously used word from training was paired with an incorrect object that was not used in training. Similarly, with the new word with old object foil, a completely new nonsense word was presented with a previously seen object from training. For the old object with the wrong old word from training foil, participants were presented with a previously heard word which was paired with an incorrect object from training.

The Yes/No Test consisted of 24 questions on paper. Additionally, the participants were asked to rate their confidence, or how sure they were, in their answers on a scale of 1-10 with 10 being very sure and 1 being not very sure. The debriefing information was presented following the test and a hard copy was provided at the back of the room where the participants would exit.

The demographics questionnaire was administered at the end of the study. The questionnaire asked for various information about the participants such as age and gender, as seen in Appendix B. The participants were also asked about their musical background and study habits. In addition to these questions, the participants were asked how distracting they felt the background noise was (either music or TV) in the experiment on a scale of 1-10 with ten being the highest level of distraction. This variable was used to measure individual perceived distraction levels; these scores were divided into high and low levels of distraction for analysis. Participants in the Silence condition were instructed to circle "None" because they did not hear any music or TV during the experiment. Additionally, the participants were asked if they recognized any of the music selections and if they knew the purpose of the study.

Procedure

Each participant was seated at a desktop PC with a pair of headphones. During each experimental session, there were up to four participants spaced out evenly in the testing room. The experiment was presented in Microsoft PowerPoint. The presentation began with a welcome screen which featured the instructions for the experiment directing the participants to pay attention to the slideshow. Participants were also informed that a quiz would follow the presentation. Participants were not informed about what the quiz would entail, only that there would be a quiz at the end of the presentation.

Each of the slides had one object with the corresponding auditory nonsense label. The participants were instructed to start the study by pressing a button; however, the slides proceeded automatically for the duration of the experiment. Each slide in the presentation was displayed for seven seconds. Throughout the presentation, the background music was played; the background music stopped when the participants reached the end of training. Then, the participants took the Yes/No test to assess their word learning, and the participants were asked to rate their confidence in their answers. Following the Yes/No test, a slide with a thank you message and instructions to complete the demographic questionnaire was displayed. After the questionnaire, the participants were free to leave. There was a copy of their debriefing statement by the exit of the testing room.

Results & Discussion

The dependent variable of this study is the participants' accuracy on the Yes/No test where a correct answer earned a score of 1 and an incorrect answer earned a score of 0. Average accuracy score was calculated for each participant. As a preliminary analysis, a Repeated Measures Analysis of Variance (ANOVA) was conducted with the independent variable being the frequency (high/low) of presentations of a nonsense word and the dependent variable being the accuracy score. Results from this analysis revealed that there were no main effects or interactions of frequency of presentations of the nonsense word, so this variable was removed from further analysis.

A one-sample t-test was calculated to show that the accuracy of the participants' scores was above .50 chance (M= .89, SD=.10), $t(98)$= 40.17, p<05. There was a significant positive correlation, r=.59, p<.05 of confidence in relation to accuracy scores. Those with higher accuracy scores had higher self-reported confidence levels in their answers. Additional analyses were conducted to identify if accuracy was affected by background noise condition. A Between-Subjects ANOVA revealed that there was no significant main effects or interactions of background noise condition on accuracy scores, $F(2,63)$= 1.06, p>.05, partial η^2=.03, as seen in Figure 1.

Distraction level was categorized as high or low based on the self-reported distraction level score given by each participant on the demographic sheet. Participants rated on a scale of 1-10, with 10 being the highest distraction level, how distracting they felt the background noise to be. Those who reported a rating score of 0-5 were put in the low distraction category (n=56); those who gave a rating score of 6-10 were put in the high distraction category (n=21). A 2(Distraction level: low, high) Univariate ANOVA on the accuracy of the participants showed there was a main effect of perceived distraction, $F(1,66)$= 5.09, p< .05, partial η^2= .07, where accuracy was worse when the distraction level was higher. See Figure 2 for means.

To investigate if background sound enjoyment hindered or helped word learning as suggested by previous literature, a 2(Enjoyment: liked, disliked) x 3(Condition: pop, calm, TV) Univariate ANOVA displayed a marginal interaction between condition and enjoyment, $F(1,20) = 6.90$, $p = .11$, $\eta^2 = .26$. An ANOVA was calculated with each condition independently to tease apart the interaction. Overall, there was a main effect of enjoyment only in the calm music condition where liked ($M = .97$ $SD = .03$) had higher accuracy scores than disliked ($M = .90$ $SD = .07$), $F(1,20) = 6.89$, $p < .05$, $\eta^2 = .26$. There was no main effect of enjoyment with the pop music because both liked music ($M = .88$, $SD = .11$) and disliked music ($M = .88$, $SD = .03$) scored similarly, which was also true of the TV condition (liked $M = .96$ $SD = .12$; disliked $M = .87$, $SD = .11$)]. Therefore, for only the calm music condition, those who did not like the music selections had higher accuracy scores than those who liked the music selections.

From Study 1, it can be concluded that song enjoyment does influence word learning in regards to calm music. Additionally there was no main effect in regards to sound condition. Perceived distraction level did have a main effect on accuracy scores; the more distraction the participants reported, the worse they performed on the word-learning task. However, participants performed near ceiling during this task, which may mean that the task was too easy to allow for effects of background sound. For this reason, further investigation was needed in a follow-up study to investigate the effect of background sound in a more difficult multi-modal word-learning task.

Study 2: Difficult Word-Learning Task

Method

Participants

There was a total of 100 native-English speaking participants (52 Females, 48 Males) in this study who were all undergraduate students taking an introductory Psychology course at a regional campus of a large Midwestern university. There were an additional 25 participants excluded from the data analyses due to incompletion of the study by either not completing the Yes/No test (*n*=12), talking throughout the experiment (*n*=3), or not answering pertinent questions on the demographic sheet (*n*=10). The participants in this study did not participate in Study 1. The age of the participants ranged from 18-30 (*M*=19.17 years, *SD*=1.51). In return for participating in the study, students received credit for their research requirements in the Introduction to Psychology class.

Materials

The words and objects selected for this experiment were the same as in Study 1. Similar to Study 1, approximately half of the words were low frequency; however, this consisted of being presented one time, and the remaining words were high frequency, which consisted of being presented two times. This led to 30 trials in total. Which words were to be high frequency or low frequency was randomly determined. All of these nonsense words were once again presented as nouns labeling an object (e.g., “This is a *floogle*”).

The background auditory stimuli were once again played through headphones. The background sound was the same from Study 1, which consisted of four between-subjects conditions: silence, calm music, pop music and TV selections. However, the noise selections were shortened for Study 2 given the fewer number of training trials. There were three different selections for each background noise condition lasting for an approximate total time of 4.5 minutes. Each background selection lasted for approximately 1.3 minutes.

Following the object and word presentation, a Yes/No test was once again given to measure how well the participants learned the nonsense words. The Yes/No test was the same Yes/No test from Study 1. Additionally, the participants were once again asked to rate their confidence in their answers by rating their confidence, or how sure they were, on a scale of 1-10 with 10 being very sure and 1 being not very sure. The demographics questionnaire was administered at the end of the study and was the same demographics questionnaire from Study 1. The debriefing information was presented following the test.

Procedure

The procedure was identical to Study 1. Each participant was seated at a desktop PC with a set of headphones. The presentation began with a welcome screen which featured the instructions for the experiment directing the participants to pay attention to the slideshow. Participants were also informed that a quiz would follow the presentation. Each slide in the presentation was displayed for a total of seven seconds. Throughout the presentation, the background sound was played; however, the background sound stopped when the participants reached the end of training. Then, the participants took the Yes/No test to assess their word learning. Following the Yes/No test, a slide with a thank you message and instructions to complete the demographic questionnaire was displayed. There was a copy of the debriefing statement by the exit of the testing room.

Results & Discussion

The dependent variable of this study is the participants' word-learning accuracy on the Yes/No test. A one-sample t-test showed that the accuracy scores were above .50 chance (M=.80 SD=.13), $t(100)=23.58$, $p<.05$. There was a positive relationship between confidence level and accuracy scores, $r=.44$, $p<.01$. Those who were more confident in their answers on the Yes/No test had higher accuracy scores. Preliminary analyses were conducted to reveal no main effect of enjoyment (like, dislike) on accuracy, $F(1,98)=.02$, $p>.05$, partial $\eta^2=.00$.

A 4(Condition: calm, pop, TV and silence) x 2(Frequency: low, high) repeated measures ANOVA on the accuracy score showed there was a main effect of Frequency, $F(1,96)= 9.04$, $p<.05$, partial $\eta^2=.09$, where accuracy was higher with a higher frequency of training presentations of the novel words (High Frequency $M=.82$, $SD=.16$; Low Frequency $M=.76$ $SD=.16$). There was also a main effect of Sound Condition, $F(3, 96)= 4.58$, $p<.05$, partial $\eta^2= .13$. See Figure 3 for means and accuracy scores. LSD Post Hoc tests revealed that participants in the Calm sound condition and Silence condition performed similarly to one another ($p>.05$), and participants in both of these conditions performed better than participants in the Pop and TV conditions (p's$<.05$). Participants in the Pop condition performed equally well as those in the TV sound condition ($p>.05$). These results indicate that background sound with vocals hinders word learning in a difficult task.

Additionally, participants were in a high or low distraction level group where an individual distraction level rating of 0-5 was considered low ($n=29$) and an individual distraction level rating of 6-10 was considered high ($n=42$). A 2(Distraction level: high, low) Univariate ANOVA) on word-learning accuracy showed there was a main effect of distraction level, $F(1,69)=6.46$, $p<.05$, partial $\eta^2=.09$. Those who reported a higher distraction level performed worse than those with lower self-reported distraction levels. See Figure 4 for mean accuracy scores. Therefore, in a more difficult multimodal task, individual perceived distraction level plays a role in word learning accuracy as well as the presence of vocals in background sound.

General Discussion

The results of these studies indicate that there was a main effect of perceived distraction across both an easy and a difficult word learning task as well as an effect of background vocals on accuracy scores in a more difficult task. Although the participants scored well in both studies, their perceived level of distraction affected their performance. In other words, the more distracted they felt during the test, the more their learning suffered. This was true regardless of the different types of background noise. However, those in a difficult word learning task in Study 2, with fewer presentations during the learning phase, were affected by the background sounds. Participants in the sound conditions with vocals (pop music and TV) performed significantly worse than participants in the non-vocal sound conditions (calm music and silence). There was a marginal significant interaction of condition and enjoyment; participants who disliked the music tended to perform better on word learning than those who liked the music in Study 1; however, this was only true in the calm condition. In addition, this marginal effect was not found in the more difficult task (Study 2). Overall, whether background noise hinders word learning is dependent on individual distraction level (as revealed in Study 1 and Study 2) and the presence of vocals (as revealed in Study 2).

The findings of these studies suggest that background noise containing words is detrimental in a difficult multi-modal cognitive task such as word learning. This finding is consistent with the previous literature regarding cognitive task performance with the presence of background music with vocals in which those in the vocal music condition performed worse in comparison to those in the non-vocal music condition (Crawford & Strapp, 1994; Salame & Baddeley, 1989). The results of this study also extend their findings beyond just music to other types of background sounds that include vocals.

The findings of Study 1 suggesting that liked music poses more of a distraction and hinders word learning performance in the Calm condition are consistent with the previous literature on the effects of liked and disliked music (Perham & Sykora, 2012). The previous literature suggests that liked music poses more of a distraction to an individual during a task and thus prevents them from attending to the task at hand resulting in worse performance. The reason for this distraction was due to the fact that people who liked the music may have paid more attention to the music rather than the stimuli being presented. This is a plausible explanation for why those in the calm condition who reported liking the music selections had lower accuracy scores than those who reported disliking the calm music selections; however, it is not clear why this effect is only present in one sound condition. This warrants further investigation. Additionally, previous literature also mentions that music with higher levels of acoustic variation distracts and hinders learning performance (Perham & Sykora, 2012). This is consistent with the findings of Study 2 in which those in the Pop and TV sound conditions performed worse. This might be due to the fact that both the Pop and TV sound conditions contain vocals, which could increase the acoustic variation (Perham & Sykora, 2012) thus creating a more distracting scenario, which is consistent with previous research (Jancke & Sandmann, 2010).

The vocal sound conditions (Pop and TV) were consistent with the findings that background noise hinders performance on unimodal cognitive tasks such as reading comprehension or prose recall (Furnham & Strbac, 2002). However, word learning was not investigated in the previous research. The current findings extend this effect to a multi-modal task (word learning). In contrast with the previous literature, those in the silent condition did not perform the best in comparison to the calm music condition. Therefore, it was not necessarily the background music that was detrimental in the previous research; it was potentially the high acoustic variability from vocals in the background music. However, previous studies did have non-vocal sound conditions (white noise and office noises), which likely had high acoustic variability, and those in these non-vocal conditions performed better than those in vocal conditions (Crawford & Strapp, 1994).

One of the deciding factors which determined if background noise was harmful was whether vocals were present. The presence of vocals in the background noise poses more of a distraction to the individual because the participant was listening to the words being spoken as well as the vocals in the song. This could have potentially resulted in lowered word learning performance depending on an individual’s perceived distraction level. Additionally, vocals in the background noise compete with the novel words being presented to the participants and make them harder to learn in contrast to when the novel words are presented with a non-vocal background noise. Vocals within background noise likely tie up more working memory resources in comparison to new words participants are trying to learn during a learning task. This can be seen in the previous literature in regards to working memory when looking at how background noise affects memory recall (Salame & Baddeley, 1989). Additionally, this information can be related to the previous research discussing the phonological loop’s relationship to working memory and how the phonological loop is responsible for verbal retention (Baddeley, Gathercole & Papagno, 1998).

As found in both studies, individual perceived distraction level does play a role in word learning where higher levels of distraction led to lower accuracy scores. This information may also explain the findings of previous literature of how background noise affects students differently depending on their study habits (Elliot & Godshall, 2001; Etaugh & Ptasnik, 1982). Participants might normally choose to study with background music when they are in their own learning environment and thus were not as distracted during the word learning task. This also could be related to individual confidence levels in a participant's answers on the Yes/No test as a result of individual perceived distraction levels. By being less distracted, participants were potentially able to make a better decision based on their knowledge gained from the word learning task and were then able to be more confident in their answers in which they chose.

One of the limitations of this study was that this task may not have been representative of how college students actually study. Future studies should attempt to mirror college students and their study habits when engaging in a learning activity. Additionally, another limitation would be that the calm and pop conditions were not only varied by the presence of vocals; they were also limited by the tempo. The pop music was generally faster in tempo in contrast to the calm music. This may have attributed to differences in accuracy scores due to the variations of sound density within the two music conditions. The pop music may have had a higher density meaning that it had multiple layers of events such as tempo, changes in melody or lyrics. One final limitation may have been the working memory abilities of the participants. For example, there may have been pre-existing differences within the participants that could have attributed to the differences in accuracy scores.

For future research, this study should be replicated; however, participants should brought back into the lab and have the experiment repeated in order to see the effects of background noise on word learning with a longer delay. This would have been an accurate mirror of how college students actually study. This study should also be investigated in young children to see how children are affected by background distractions. This information would be useful because early childhood is when vocabulary develops very rapidly (Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991), so knowledge of environmental barriers to word-learning would have realworld applications. For example, it would be beneficial to learn which environments are more conducive for word-learning in order to help build a child's vocabulary. The implications of this research may be far-reaching and should be investigated across different types of learning, such as learning how to build vocabulary. This information infers to educators that early learning performance is a good predictor of success later in life. Therefore, by placing an emphasis of improving the performance of struggling students, and by creating more conducive learning environments early on, educators and researchers can better improve a child's ability to succeed later in life academically. By understanding how various factors of background noise affect learning, education systems can create better learning environments for children of all ages.

References

Baddeley, A., Gathercole, S., & Papagno, C. (1998). The phonological loop as a language learning device. *Psychological review*, *105*(1), 158.

Crawford, H. J., & Strapp, C. M. (1994). Effects of vocal and instrumental music on visuospatial and verbal performance as moderated by studying preference and personality. *Personality and Individual Differences*, *16*(2), 237-245.

Elliot, T. R., Godshall, F., Shrout, J. R., & Witty, T. E. (1990). Problem-solving appraisal, self-reported study habits, and performance of academically at-risk college students. *Journal of Counseling Psychology*, *37*(2), 203.

Etaugh, C., & Ptasnik, P. (1982). Effects of studying to music and post-study relaxation on reading comprehension. *Perceptual and Motor Skills*, *55*, 141-142.

Furnham, A., & Strbac, L. (2002). Music is as distracting as noise: The differential distraction of background music and noise on the cognitive test performance of introverts and extroverts. *Ergonomics*, *45*, 203-217.

Furnham, A., & Allas, K. (1999). The influence of musical distraction of varying complexity on the cognitive performance of extroverts and introverts. *European Journal of Personality*, *13*, 27-38.

Hoover, A., & Krishnamurti, S. (2010). Survey of college students’ MP3 listening: Habits, safety issues, attitudes, and education. *American Journal of Audiology*, *19*, 73-83.

Huttenlocker, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early vocabulary growth: Relation to language input and gender. *Developmental Psychology*, *27*, 236-248.

Jancke, L., & Sandmann, P. (2010). Music listening while you learn: No influence of background music on verbal learning. *Behavioral and Brain Functions*, *11*, 445-455.

Kiger, D. M. (1989). Effects of music information load on a reading comprehension task. *Perceptual and Motor Skills*, *69*(2), 531-534.

Lavie, N. (2005). Distracted and confused?: Selective attention under load. *TRENDS in Cognitive Sciences, 9,* 75-82.

Lyxell, B., & Ronnberg, J. (1993). The effects of background noise and working memory on speechreading performance. *Scandinavian Audiology, 1993, 22,* 67-70.

Pashler, H., Kang, S. H., & Ip, R. Y. (2013). Does Multitasking Impair Studying? Depends on Timing. *Applied Cognitive Psychology*, *27*(5), 593-599.

Perham, N., & Sykora, M. (2012). Disliked music can be better for performance than liked music. *Applied Cognitive Psychology*, *26*, 550-555.

Salamé, P., & Baddeley, A. (1989). Effects of background music on phonological short-term memory. *The Quarterly Journal of Experimental Psychology*, *41*, 107-122.

Figure 1. Study 1 Accuracy Score Means for Each Condition. Error bars represent standard error of the means.

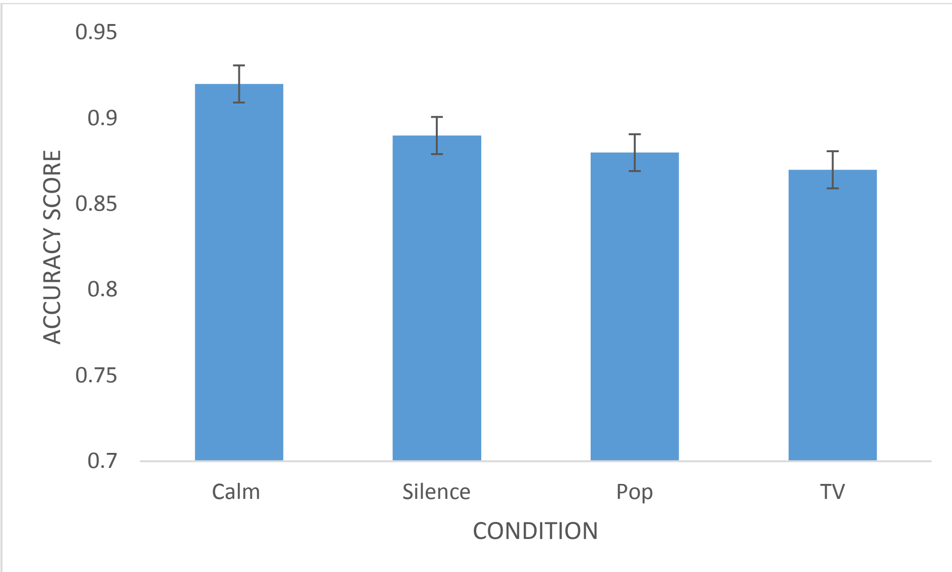


Figure 2. Study 1 Individual Perceived Distraction Level: Means for Each Condition. Error bars represent standard error of the means.

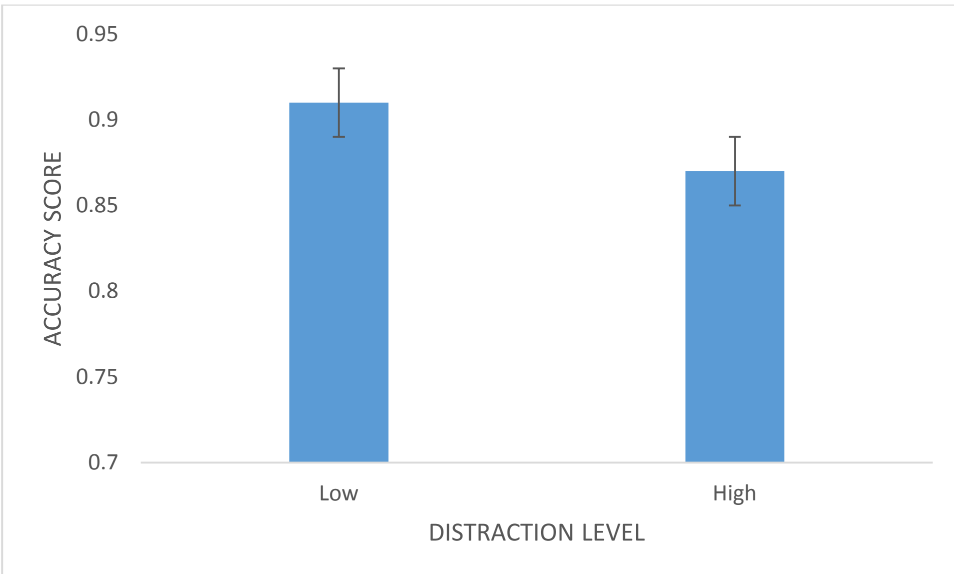


Figure 3. Study 2 Accuracy Scores: Means for Each Condition. Error bars represent standard error of the means.

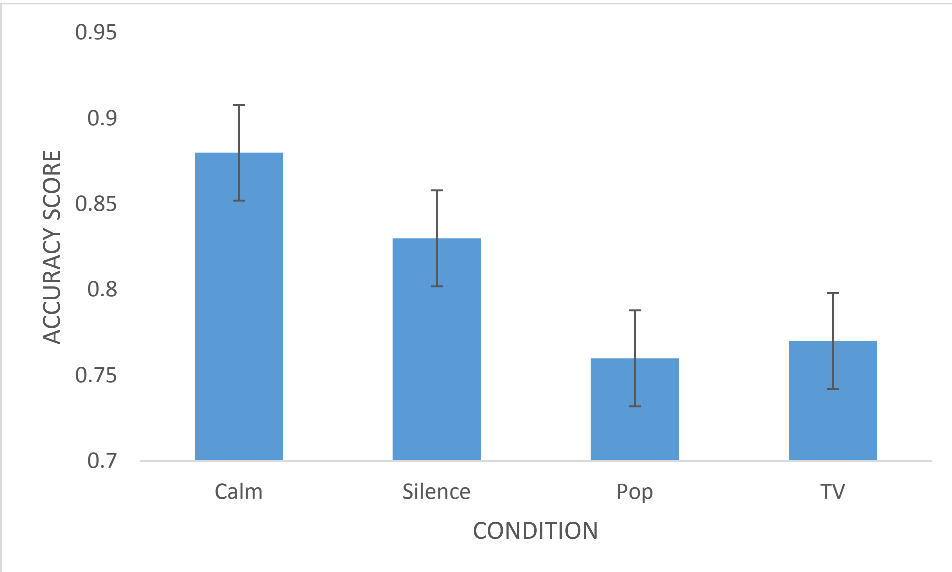
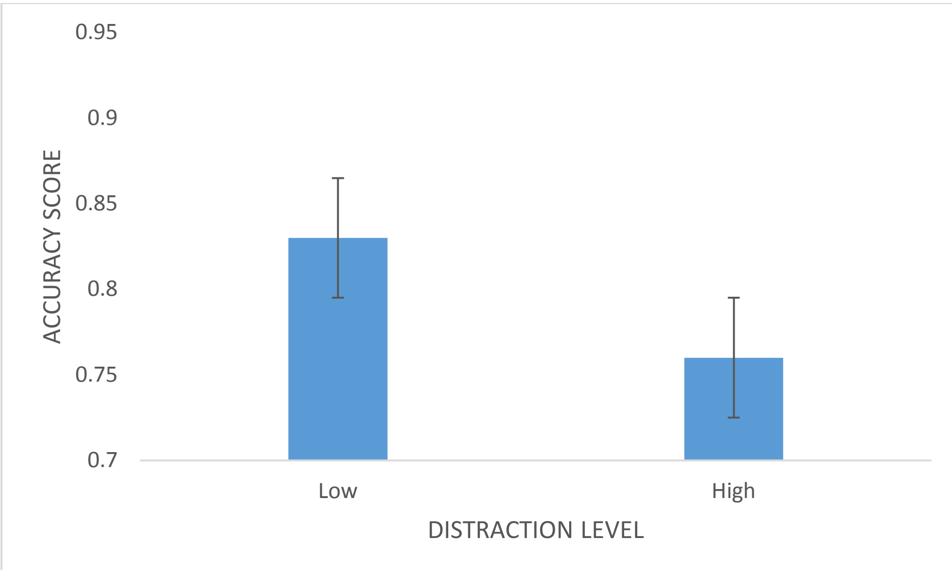


Figure 4. Study 2 Individual Perceived Distraction Level: Means for Each Condition. Error bars represent standard error of the means.



Appendix A

Words with Corresponding Objects

1. Brumbank

2. Callay

3. Calooh

4. Fap

5. Floogle

6. Folix

7. Labit

8. Lex

9. Mog

10. Pawdle

11. Plorkin

12. Poth

13. Quib

14. Sith

15. Tamel

16. Tup

17. Wid

18. Wub

19. Yat

20. Zotel

Appendix B

Demographics Sheet

Participant number __________
Condition __________

Demographics, Music, and Language Background

1. What is your gender? Male ______ Female ______

2. What is your age? ________

3. What is your race/ethnicity? (*check all that apply*)

______ Black or African American
______ Asian
______ Native Hawaiian or other Pacific Islander
______ White
______ American Indian or Alaska Native / First Nations
______ Hispanic or Latino
______ Other: ___________________________

4. What musical instrument(s) do you play, if any? How many years have you been playing each instrument?

5. How many years of private instruction on each instrument have you had?

6. At what age did you start lessons?

7. Do you still play these instruments? If so, which ones and how many hours a week?

8. How often do you take music lessons?

9. When/where do you listen to music? Circle all that apply:

car work studying meals working out bedtime other: _____________

10. Do you teach music lessons, and if so, for how long?

11. Are you right- or left-handed? LEFT / RIGHT

12. Do you have any hearing problems? YES / NO

13. What language(s) was spoken in your home before you were 3 years old?

14. What language(s) do you speak fluently?

15. What genre(s) of music do you listen to normally? Circle all that apply:

Classical Rock/Metal Rap/ R&B Country Religious Popular Other:____________

16. On a scale of 1-10, with 10 being the highest level of distraction, how distracting was the music that you heard during the experiment? If you did not hear any music, circle “none”.

NONE Not distracting 1 2 3 4 5 6 7 8 9 10 Very distracting

17. Do you listen to music while you study? YES / NO

18. If you answered YES to number 17, how often do you study with music playing in the background?
____ Every time I study
____ Often when I study
____ Occasionally when I study
____ Do not listen to music while I study

19. Did you recognize any of the music selections played during the experiment? If you did not hear any music, circle “none”.

NONE / YES / NO

20. Did you like the overall music selections played during the experiment? YES / NO

21. Do you have the TV on while you study? YES / NO

22. If you answered YES to number 21, how often do you have the TV while you study.
____ Every time I study
____ Often when I study
____ Occasionally when I study
____ Do not watch TV while I study.

23. If you answered YES to number 21, what kind of TV shows do you have on while you study? *(circle all that apply)*

News Reality TV Sports Movies Cartoons Sitcoms/Drama/Music TV

Other:__________________________

24. On a scale of 1-10, with 10 being the highest level of distraction, how distracting was the TV selections that you heard during the experiment. If you did not hear any TV during the experiment circle “NONE”.

NONE Not distracting 1 2 3 4 5 6 7 8 9 10 Very distracting

What was the purpose of this study?

____

____